SECTION 16792A

WIRE LINE DATA TRANSMISSION SYSTEM

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15	Radio Frequency Devices

INTERNATIONAL TELECOMMUNICATION UNION (ITU)

ITU-01	(1988) Data Communication Over the Telephone Network, Series V Recommendations (CCITT Blue Book - Vol VIII - Fascicle VIII.1)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-80-576	(1994) Communications Wire and Cable for Wiring of Premises
ICEA S-84-608	(1994) Telecommunications Cable, Filled Polyolefin Insulated Copper Conductor

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1997) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code

U.S. DEPARTMENT OF AGRICULTURE (USDA)

REA Bulletin 1753F-205 (PE-39)	(1993) REA Specifications for Filled Telephone Cables

1.2 SYSTEM DESCRIPTION

1.2.1 General

A half or full duplex wire line data transmission system (DTS) for communication between a local device and a central processor shall be

provided. The local device is used to process locally generated information and communicates that information to the central processor. The central processor is a computer-based system that takes the information received from the local processor and processes that information. The DTS shall consist of MODEMS (headend and remote) and line drivers, or both, connected to the local device and the central processor. The MODEMS are connected by transmission lines and terminal devices such as connectors and terminal strips. Communication links surge protection and powerline surge protection shall be provided at both ends of the transmission line. All computing devices, as defined in 47 CFR 15, shall be certified to comply with the requirements for Class B computing devices and labeled as set forth in 47 CFR 15.

1.2.2 Environmental Requirements

Equipment and cable to be used indoors shall be rated for continuous operation under ambient environmental conditions of 0 to 50 degrees C (35 to 120 degrees F) dry bulb and 10 to 95 percent relative humidity, noncondensing. Equipment and cable to be used outdoors shall be rated for continuous operation under ambient environmental conditions of minus 40 to plus 70 degrees C (minus 40 to plus 176 degrees F) and humidity of up to 100 percent condensing or as normally encountered for the installed location. All equipment shall be rated for continuous operation under the ambient vibration conditions encountered for the installed location. Components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust or ignitable fibers or flyings, shall be rated and installed in accordance with Chapter 5 of NFPA 70 and as shown.

1.2.3 Electrical Requirements

The equipment shall operate from a voltage source as shown, plus or minus 10 percent.

1.2.4 Power Line Surge Protection

All equipment connected to ac circuits shall be protected from power line surges. Equipment shall withstand surge test waveforms described in IEEE C62.41. Fuses shall not be used for surge protection.

1.2.5 Communications Circuit Surge Protection

All communications equipment shall be protected against surges induced on any communications circuit. All cables and conductors which serve as communications circuit between the local processor and the central processor shall have surge protection devices installed at each end. Protection shall be provided at the equipment and additional triple electrode gas surge protectors rated for the application on each wireline circuit shall be installed within 1 m (3 feet) of the building cable entrance. Fuses shall not be used for surge protection. The inputs and outputs shall be tested in both normal mode and common mode using the following two waveforms:

a. A waveform with a 10 microsecond rise time, a 1000 microsecond width, a peak voltage of 1500 volts and a peak current of 60 amperes.

b. A waveform with an 8 microsecond rise time, a 20 microsecond waveform, a peak voltage of 1000 volts and a peak current of 500 amperes.

1.3 DELIVERY OF TECHNICAL DATA

All items of technical data which are specifically identified in this specification will be delivered strictly in accordance with the CONTRACT CLAUSES, SPECIAL CONTRACT REQUIREMENTS, Section 01330 SUBMITTAL PROCEDURES and the Contract Data Requirements List, DD Form 1423, which is attached to and made a part of this contract. Technical data submitted shall be coordinated with the requirements of Section [_____]. All data delivered shall be identified by reference to the particular specification paragraph against which it is furnished.

1.3.1 Group I Technical Data Package

1.3.1.1 System Drawings

The data package shall include the following:

a. Data Transmission system block diagram.

b. MODEMS and line drivers or both, installation, block diagrams, and wiring diagrams.

c. MODEMS and line drivers or both, physical layout and schematics.

d. Details of connections to power sources, including grounding.

e. Details of interconnection with served system components.

f. Details of surge protection device installation.

g. Details of cable splicing and connector installation.

h. Details of underground, aerial, and messenger cable installation on poles, cable entrance to building.

1.3.1.2 Manufacturers' Data

The data package shall include manufacturers' data for all materials including field and system equipment provided under this specification.

1.3.1.3 DTS Description and Analyses

The data package shall include complete system descriptions, analyses, and calculations used in selecting equipment required by these specifications. Descriptions and calculations shall show how the equipment will operate as a system to meet the performance of this specification. The data package shall include the following:

a. MODEM or line driver receive and transmit levels, signal-to-noise ratio calculations and assumed losses in decibels (dB) on each communication circuit.

b. Communication speed and protocol description.

c. Data transmission system expansion capability and method of implementation.

1.3.1.4 Certifications

All specified manufacturer's certifications shall be included with the data package.

1.3.2 Site Conditions

The Contractor shall verify that site conditions are in agreement with the design package. The Contractor shall submit a report to the Government documenting changes to the site, or conditions that affect performance of the system to be installed. For those changes or conditions which affect system installation or performance, provide (with the report) specification sheets, or written functional requirements to support the findings, and a cost estimate to correct the situation. The Contractor shall not perform any corrections without written permission from the Government.

1.3.3 Factory Test

The Contractor shall prepare a test plan and test procedures in accordance with Section [_____] for the factory test. The test plan shall describe the applicable tests to be performed, and other pertinent information such as specialized test equipment required, length of factory test, and location of the factory test/predelivery test. The procedures shall explain in detail, step-by-step, actions and expected results to demonstrate compliance with the requirements of this specification, and the methods for simulating the necessary conditions of operation to demonstrate performance of the system. The Contractor shall deliver the test plan for the factory test/predelivery test to the Government. After receipt by the Contractor of written approval of the test plan, the Contractor shall deliver the factory test/predelivery test procedures to the Government for approval. After receipt by the Contractor of written approval of the factory test/predelivery test procedures, the Contractor may schedule the factory test/predelivery test.

1.3.4 Performance Verification Testing and Endurance Testing Data

The Contractor shall prepare a test plan and test procedures in accordance with Section [_____] for the performance verification test and endurance test. The test plan shall describe the applicable tests to be performed, and other pertinent information such as specialized test equipment required, and length of performance verification test. The test procedures shall explain in detail, step-by-step actions and expected results to demonstrate compliance with the requirements of this specification. The Contractor shall deliver test plans for the performance verification test and endurance test to the Government. After receipt by the Contractor of written approval of the test plans, the Contractor shall deliver the performance verification test and endurance test procedures for approval. Written approval by the Government of the performance verification test procedures shall be one of the prerequisites for commencing the performance verification test as specified.

1.3.5 Operation and Maintenance Data

A draft copy of the operation and maintenance data, shall be delivered to the Government prior to beginning the performance verification test for use during site testing.

1.3.6 Training Data

Lesson plans and training data in manual format for the training phases, including type of training to be provided, with a list of reference material, shall be delivered for approval.

1.3.7 Manuals

Final copies of the manuals bound in hardback, loose-leaf binders, shall be delivered to the Government within 30 days after completing the endurance test. The draft copy used during site testing shall be updated with any changes required prior to final delivery of the manuals. Each manual's contents shall be identified on the cover. The manuals shall include the names, addresses, and telephone numbers of each subcontractor installing equipment and systems, and of the nearest service representative for each item of equipment and each system. The manuals shall have a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. The final copies delivered after completion of the endurance test shall include all modifications made during installation, checkout, and acceptance. Manuals delivered shall include:

a. Functional Design Manual: [two] [_____] copies.

b. Hardware Manual: [two] [_____] copies.

c. Operator's Manual: [six] [_____] copies.

d. Maintenance Manual: [two] [_____] copies.

1.3.7.1 Functional Design Manual

The functional design manual shall identify the operational requirements for the data transmission system and explain the theory of operation, design philosophy, and specific functions. A description of hardware functions, interfaces, and requirements shall be included for all system operating modes.

1.3.7.2 Hardware Manual

A manual describing all equipment furnished, including:

a. General description and specifications.

b. Installation and checkout procedures.

c. Equipment electrical schematics and layout drawings.

d. Data transmission system schematics.

e. Alignment and calibration procedures.

f. Manufacturer's repair parts list indicating sources of supply.

g. Interface definition.

1.3.7.3 Operator's Manual

The operator's manual shall fully explain all procedures and instructions for operation of the system.

PART 2 PRODUCTS

2.1 COMMUNICATIONS EQUIPMENT

Communications equipment for circuits between sensors and field processors, and between the field processors and central processor, shall be capable of transmitting data within the error rate specified over the distances shown.

2.1.1 Modems

Modems shall conform to ITU-01 for a data rate of at least 9600 bits per second (bps).

2.1.2 Line Drivers

Line drivers shall transmit data at a minimum of 9600 bps over the distances as shown.

2.2 WIRELINE CABLE

Wireline cable shall be insulated solid copper type conforming to the following specifications. A minimum of No. 22 AWG shall be used for all applications.

2.2.1 Cable Construction

All cable components shall be able to withstand the environment the cable is installed in for a minimum of 20 years.

2.2.2 Underground Cable

ICEA S-84-608.

2.2.3 Aerial Cable

ICEA S-84-608.

2.2.4 Direct Burial Cable

REA Bulletin 1753F-205 (PE-39).

2.2.5 Interior Cable

Current issue of the NFPA 70 or ICEA S-80-576.

2.3 RACEWAY SYSTEMS

Raceway systems as specified in Section 16415 ELECTRICAL WORK, INTERIOR and Section 16375 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND and as shown shall be furnished.

2.4 ENCLOSURES

Enclosures shall conform to the requirements of NEMA 250 for the types specified. Finish color shall be the manufacturer's standard, unless otherwise indicated. Damaged surfaces shall be repaired and refinished using original type finish. The Contractor shall provide metallic enclosures to house the wireline DTS equipment. The enclosures shall be as specified or shown.

2.4.1 Interior

Enclosures to house wireline DTS equipment in an interior environment shall meet the requirements of NEMA 250, Type 12.

2.4.2 Exterior

Enclosures to house wireline DTS equipment in an outdoor environment shall meet the requirements of NEMA 250, Type 4.

2.4.3 Corrosion Resistant

Enclosures to house wireline DTS equipment in a corrosive environment shall meet the requirements of NEMA 250, Type 4X.

2.4.4 Hazardous Environment

Enclosures in a hazardous environment shall be installed as described in paragraph ENVIRONMENTAL REQUIREMENTS.

2.5 MESSENGER CABLE

A messenger cable system to support all aerial cable shall be furnished. The messenger system shall include all guys, hardware and appurtenances needed to install the messenger cable. The messenger system shall be capable of supporting the weight of the DTS cable with the required messenger cable tensioning without exceeding 30 percent of its breaking strength under 16 degrees C (degrees 60 F) conditions of no ice and no wind. The messenger shall be sized so that ice and wind loading normally encountered at the site does not cause the messenger to exceed 50 percent of its breaking strength. All appurtenances, guys, and hardware shall be sized to exceed the rated breaking strength of the messenger cable. Messenger cables shall be galvanized zinc coated steel or aluminum clad steel.

2.6 TAMPER PROVISIONS

Enclosures, cabinets, housings, boxes, raceways, conduits, and fittings of every description having hinged doors or removable covers, and which contain any part of the DTS circuits or power supplies, shall be provided with cover operated, corrosion-resistant tamper switches, arranged to initiate an alarm signal when the door or cover is moved. Tamper switches shall be mechanically mounted to maximize the defeat time when enclosure covers are opened or removed. The enclosure and the tamper switch shall function together to disallow direct line of sight to any internal components and

tampering with the switch or the circuits before the switch activates. Tamper switches shall be inaccessible until the switch is activated; have mounting hardware concealed so that the location of the switch cannot be observed from the exterior of the enclosure; be connected to circuits which are under electrical supervision at all times, irrespective of the protection mode in which the circuit is operating; shall be spring loaded and held in the closed position by the door cover; and shall be wired so that they break the circuit when the door or cover is disturbed. Tamper switches on the doors which must be opened to make routine maintenance adjustments to the system and to service the power supplies shall be push/pull-set, automatic reset type.

2.6.1 Enclosure Covers

Covers of pull and junction boxes provided to facilitate installation of the system need not be provided with tamper switches if they contain no splices or connections, but shall be protected by tack welding or brazing the covers in place. Zinc labels shall be affixed to such boxes indicating they contain no connections. These labels shall not indicate that the box is part of the security system.

2.6.2 Conduit-Enclosure Connections

All conduit-enclosure connections shall be protected by tack welding or brazing the conduit to the enclosure. Tack welding or brazing shall be done in addition to standard conduit-enclosure connection methods as described in NFPA 70.

2.6.3 Locks and Key-Lock Switches

2.6.3.1 Locks

All locks required to be installed on system enclosures for maintenance purposes shall be UL listed, [round-key type, with three dual, one mushroom, and three plain pin tumblers] [or] [conventional key type lock having a combination of five cylinder pin and five-point three position side bar]. Keys shall be stamped "U.S. GOVT. DO NOT DUP." The locks shall be so arranged that the key can only be withdrawn when in the locked position. All maintenance locks shall be keyed alike and only two keys shall be furnished for all of these locks.

2.6.3.2 Key-Lock-Operated Switches

All key-lock-operated switches required to be installed on system components shall be UL listed, [round-key type, with three dual, one mushroom, and three plain pin tumblers] [or] [conventional key type lock having a combination of five cylinder pin and five-point three position side bar]. Keys shall be stamped "U.S. GOVT. DO NOT DUP." Key-lock-operated switches shall be two position, with the key removable in either position. All key-lock-operated switches shall be keyed differently and only two keys shall be furnished for each key-lock-operated-switch.

PART 3 EXECUTION

3.1 INSTALLATION

System components and appurtenances shall be installed in accordance with the manufacturer's instructions and as shown. All necessary interconnections, services, and adjustments required for a complete and operable data transmission system shall be provided. Loading coils shall not be installed on cables provided for use with line drivers.

3.1.1 Enclosure Penetrations

Enclosure penetrations shall be from the bottom unless the system design specifically requires penetrations from other directions. Penetrations of interior enclosures involving transitions of conduit from interior to exterior, and all penetrations on exterior enclosures shall be sealed with rubber silicone sealant to preclude entry of water. The conduit riser shall terminate in a hot-dipped galvanized metal cable terminator. The terminator shall be filled with an approved sealant as recommended by the cable manufacturer, and in such a manner that the cable is not damaged.

3.1.2 Interior Electrical Work

Interior electrical work shall be installed as specified in Section 16415 ELECTRICAL WORK, INTERIOR and as shown.

3.1.3 Exterior Electrical Work

3.1.3.1 Underground

Except as otherwise specified, underground electrical and communications work shall be installed as specified in Section 16375 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND and as shown.

a. Minimum burial depth for cable shall be 800 mm, (30 inches,) but not less than the depth of the frost line.

b. Where direct burial cable will pass under sidewalks, roads, or other paved areas, the cable shall be placed in minimum 25 mm (1 inch) rigid coated galvanized coated steel conduit. Conduit may be installed by jacking or trenching, as approved.

c. All buried cable shall be placed below a minimum 76.2 mm (3 inch) wide plastic warning tape buried in the same trench or slot. The tape shall be 300 mm (12 inches) above the cable. The warning tape shall be continuously imprinted with the words "WARNING - COMMUNICATION CABLE BELOW" at not more than 1.2 m (48 inch) intervals. The plastic tape shall be acid and alkali resistant polyethylene film, 7.62 mm (3 inches) wide with a minimum thickness of 102 micrometers. (0.004 inch.) Tape shall have a minimum strength of 12.1 MPa (1750 psi) lengthwise and 10.3 MPa (1500 psi) crosswise.

d. Transitions from underground cable to aerial cable shall be as specified in paragraph CONNECTIONS BETWEEN AERIAL AND UNDERGROUND SYSTEMS in Section 16375 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND.

e. Splices shall be installed in cable boxes. Sufficient cable shall be provided in each splicing location to properly rack and splice the cables, and to provide extra cable for additional splices. All

able ends shall be protected at all times with end caps except during actual splicing. During the splicing operations, means shall be provided to protect the unspliced portions of the cable from the intrusion of moisture and other foreign matter.

f. For cable installed in duct and conduit, a cable feeder guide shall be used between the cable reel and the face of the duct and conduit to protect the cable and guide it into the duct and conduit as it is played off the reel. As the cable is played off the reel, it shall be carefully inspected for jacket defects. Precautions shall be taken during installation to prevent the cable from being "kinked" or "crushed." A pulling eye shall be attached to the cable and used to pull the cable through the duct and conduit system. Cable shall be hand fed and guided through each manhole. As the cable is played off the reel into the cable feeder guide, it shall be sufficiently lubricated with a type of lubricant recommended by the cable manufacturer. Where the cable is pulled through a manhole, additional lubricant shall be applied at all intermediate manholes. Dynamometers or load-cell instruments shall be used to ensure that the pulling line tension does not exceed the installation tension value specified by the cable manufacturer. The mechanical stress placed upon a cable during installation shall be such that the cable is not twisted or stretched.

3.1.3.2 Aerial

LOADING CONDITIONS FOR AERIAL COMMUNICATION CABLES

	COMBINED ICE & WIND LOADING	EXTREME WIND LOADING
Radial Thickness of Ice mm (Inches)		
Horizontal Wind Pressure Pa (psf)		
Temperature degrees C (degrees F)		

Except as otherwise specified or shown, aerial communications work shall be installed as specified in Section 16370 ELECTRICAL DISTRIBUTION SYSTEM, AERIAL.

a. Messenger Cable Installation:

Messengers shall be attached to poles with approved clamps and not less than 15.9 mm (5/8 inch) through bolts. Messenger cable tensioning shall not exceed 30 percent of its rated breaking strength under 16 degrees C (60 degrees F) conditions of no ice and no wind. Messenger shall be stressed to a tension higher than the final tension in order to prestretch the cable, so that when the messenger is dead-ended under its final tension and sag, there will be minimum variation from the calculated values. Messengers shall be grounded and guyed at all corners, dead-ends, entrances to each facility, and grounded at intervals not exceeding 300 m. (1000 feet.) [New grounding conductors and electrodes shall be provided

at each ground connection.] [Where grounding connections are made in the vicinity of existing grounding conductors and electrodes, the grounding connection may be made by a bolted or welded connection to the existing grounding conductor.] Ground conductors shall be soft drawn copper, having a current capacity of at least 20 percent of that of the messenger to which it is connected. Ground conductors shall not be smaller than No. 6 AWG. The ground conductor shall be connected to a copper or copper-clad steel ground rod not less than 19.1 mm (3/4 inch) in diameter, and length shall be as needed to achieve the specified ground resistance. After installation is completed, the top of the ground rod shall be approximately 300 mm (1 foot) below finished grade. The ground conductor shall be protected by half-round wood, plastic, or fiber molding from the ground to a point at least 2.4 m (8 feet) above the ground. Ground resistance shall be measured in normally dry conditions, not less than 48 hours after a rainfall, and the total ground resistance shall not exceed 25 ohms.

b. Transitions from Aerial Cable to Underground: Transitions from aerial cable to underground cable shall be as specified in paragraph CONNECTIONS BETWEEN AERIAL AND UNDERGROUND SYSTEMS in Section 16370 ELECTRICAL DISTRIBUTION SYSTEM, AERIAL.

c. Aerial Cable Splices: All splices in aerial cable shall be within 1 m (3 feet) of a pole and placed inside a watertight enclosure. Drip loops shall be formed at the cable entrance to the enclosure. Lashing clamps shall be placed within 300 mm (12 inches) of the enclosure.

d. Lashing Wire: Lashing wire shall be wound tightly around both the communication cable and the messenger cable by machine methods. The lashing wire shall have a minimum of 1 turn per 350 linear mm (14 linear inches) and not less than the number of turns per linear mm (linear foot) that is recommended by the cable manufacturer for the distance between cable support points and the combined ice and wind loading and extreme wind loading shown or normally encountered for the installed location. Lashing clamps shall be placed at all poles and splices.

e. Stress Loops: Loops shall be formed in the aerial cable at all points of connection and at all poles to prevent damage from thermal stress and wind loading. The DTS cable shall be protected from chafing and physical damage with the use of spiral cut tubing and PVC tape, or plastic sleeves. The ground clearance of installed cabling shall be as shown.

f. Enclosure Penetrations: All enclosure penetrations shall be from the bottom and shall be sealed with rubber silicone sealant to preclude the entry of water.

g. Identification and Labeling: The Contractor shall supply identification tags or labels for each cable. The labeling format shall be identified and a complete record shall be provided to the Government with the final documentation. Each cable shall be identified by type of signal being carried and termination points.

3.2 TESTING

The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all testing.

3.2.1 Wire Line Test

The Contractor shall test each wire line pair. The Contractor shall prepare reports containing test results and shall certify in the reports conformance to the following requirements.

3.2.1.1 Attenuation

Measurements shall be made with test tone of 1004 Hz at 0 dBm. Attenuation distortion not to exceed minus 3 dB to plus 12 dB from 300 to 3,000 Hz, and minus 2 dB to plus 8 dB from 500 to 2,500 Hz referenced to the attenuation of the 1004 Hz test tone. Attenuation at 1004 Hz of less than 40 dB.

3.2.1.2 Envelope Delay

Envelope delay distortion no greater than 1,750 microseconds over a range of 800 to 2,600 Hz.

3.2.1.3 Insulation Resistance

Insulation resistance wire to wire of wireline pair of at least 16,093 megohm-km (10,000 megohm-miles) measured at 22 degrees C. (72 degrees F.)

3.2.1.4 Loop Resistance

Loop resistance of less than 1,500 ohms.

3.2.2 Contractor's Field Test

The Contractor shall verify complete operation of the DTS during Contractor's Field Testing as specified in Section [_____]. Field test shall include a bit error rate test. The Contractor shall perform the test by sending a minimum of 100,000 bits of data on each communication link and measuring errors. The bit error rate shall be not greater than 1 out of 100,000 for each link. The Contractor shall prepare a report containing results of the field test.

3.2.3 Verification Test and Endurance Test

The wire line data transmission system shall be tested during the Performance Verification Test and Endurance Test as specified in Section [_____].

-- End of Section --